

Appn. Number: 10/754,340 (Wang)

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**SPECIFICATION:**

Page 8, first paragraph under section "DETAILED DESCRIPTION", replace with the following new paragraphs:

The present invention relates to the receiver design in communications systems. In a communications system, the receiver has means of estimating the composite CIR  $h(t)$ . For example, in a wireless CDMA system,  $h(t)$  can be estimated from a pilot channel. It should be noted that estimating the composite CIR is entirely different from the multipath-based channel estimation used in conventional rake and G-rake receivers.

In conventional rake and G-rake receivers, channel estimation comprises multiple steps. First, the path searcher in the receiver searches for multipaths, generally at lower sampling rate, e.g., at 1x or 2x oversampling, in order to reduce the computation and power consumption. Once a multipath (finger) is detected at certain location, the tracker in the receiver will further refine the location of that multipath at higher sampling rate, e.g., 4x or 8x. The tracker is also responsible to estimate the complex amplitude of the multipath. Finally, since the location and complex amplitude of the multipath changes over time, the tracker need to track all the changes in the multipath. At any time instant, the receiver will use the output of the tracker, namely, locations and complex amplitudes of all detected multipaths as the estimated CIR.

The shortcomings of multipath-based channel estimation are well described in section "BACKGROUND - DESCRIPTION OF PRIOR ART". These shortcomings become more prominent when the multipaths are closely spaced, usually less than one chip. Such a scenario is typical in wireless cellular networks. In such cases, since the overlapping multipaths interfere with each other, their locations and complex amplitude cannot be accurately determined. When such an estimated CIR was used to compute noise covariance matrix, as illustrated in references of Wang and Kutz cited in heretofore, the estimation errors magnifies themselves in the computed values, resulting in significant performance degradation.

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In contrast, the present invention estimates the composite CIR directly. Every sample point within the span of the composite CIR is used to provide the estimated value of the composite CIR at that sample point. This approach completely discards the notion of the "multipath", and thus avoids estimation of the locations and complex amplitudes of the multipaths, a crucial step for multipath-based channel estimation used in conventional rake and G-rake receivers. Consequently, the present invention completely eliminates the disadvantages of the multipath-based channel estimation, and substantially improves the performance. Since no underlying multipath is considered in the composite CIR, higher sampling rate, such as 4x or 8x, is unnecessary – there is no need to align the peak of a multipath with a sample point as closely as possible, which will conserve significant amount of power, a precious resource in a cellular handset. There also exist various techniques that make the estimation of the composite CIR very computationally efficient.

Assuming that the composite CIR is available, the noise covariance of the received signal can be derived. Given the channel-tap locations  $t_0, t_1, \dots, t_{M-1}$ , let

$\mathbf{h} = [h_0, h_1, \dots, h_{M-1}]^T = [h(t_0), h(t_1), \dots, h(t_{M-1})]^T$  be the channel response vector. The received vector  $\mathbf{r}$  with respect to the data symbol  $b$  can be written as

$$\mathbf{r} = \mathbf{h}b + \mathbf{z}, \quad (1)$$

where  $\mathbf{z}$  is the noise vector. In a wireless CDMA cellular system,  $\mathbf{z}$  can be modeled as the sum of the intracell interference and additive white Gaussian noise (AWGN), where the AWGN consists of the intercell interference and thermal noise. Consequently, the covariance matrix  $\mathbf{R}$  of  $\mathbf{z}$  can be written as

$$\mathbf{R} = \mathbf{R}_{BC} + \mathbf{R}_{AWGN}, \quad (2)$$

where  $\mathbf{R}_{BC}$  and  $\mathbf{R}_{AWGN}$  are the contributions to  $\mathbf{R}$  from the intracell interference (the interference from the base cell, the base-cell component) and the AWGN, respectively.